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(54) **Thermal printer and printing method thereof**

Thermo-Drucker und Druckverfahren

Imprimante thermique et méthode d'impression

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- **PATENT ABSTRACTS OF JAPAN vol. 8 no. 170 (M-315) [1607] ,7 August 1984 & JP-A-59 064373 (SANYO DENKI K.K.) 12 April 1984,**

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Description

Background of the Invention

The present invention relates to a thermal printer and printing method thereof, and more particularly (though not exclusively), to a thermal printer for compensating for a picture quality deterioration due to a common drop and a temperature characteristic of a thermal print head, and printing method thereof.

In general, examples of an apparatus for printing using a thermal print head (TPH) are a thermal printer, a colour copier, a facsimile, etc. Among these, a sublimation-type thermal printer prints a desired image or picture according to the transfer amount of dye on a sheet of recording paper, by applying energy to the TPH and sublimating the dye of a dye-deposited film by the energy emitted from the TPH.

A conventional thermal printer stores one frame of image data to be printed in its frame memory 10, as shown in FIG. 1.

When printing starts, the frame memory 10 transfers one line of the image data to be printed to a line memory 20 and a first selection contact point aO of a controlling switch 51, at the same time.

The one line of image data to be printed is synchronized with the clock generated in a clock generator 31 and stored in the line memory 20 according to the address generated in an address counter 32. Gradation counter 33 generates gradation data having a value of 0-255, given that the image data is expressed in eight-bit form, and outputs as an input signal of a comparator 34.

When data is read from line memory 20 and actually printed in TPH 40, the data is printed according to gradation. For example, if image data consists of eight bits, gradation levels represented as values from 0 to 255 can be indicated and TPH 40 prints 255 times, from gradation 1 to gradation 255, with respect to each pixel.

The gradation counter 33 increases the counter values from 1 to 255. Then, the output of gradation counter 33 and the eight bit image data of line memory 20 are compared with respect to their gradations, in the comparator 34. As the result thereof, the output of comparator 34 becomes "high" or "low," thereby determining whether the dots of TPH 40 are to emit heat or not.

Meanwhile, controlling switch 51, dot number computing memory 52, dot number computing controller 53, common drop correcting ROM 54, and strobe signal generator 55 constitute a common drop correcting unit 50 for compensating picture quality deterioration due to a common drop of TPH 40.

Analog-to-digital converter 61, temperature correcting ROM 62, and power source 63 composed of a switching mode power supply (SMPS) and a detecting temperature thermistor (neither being shown in detail) attached to the back side of the heating element substrate 2 (see FIG.2) of TPH 40 constitute a temperature correcting unit 60 for compensating for picture quality deterioration due to TPH temperature change.

Here, the common drop of TPH means a generation of a voltage drop due to the parasitic resistance components present within the TPH 40. If the energy applied to the dots of the TPH 40 is varied by the voltage drop, a picture quality deterioration is generated.

In other words, assuming that reference letter V represents the voltage applied to the respective heat elements and reference letter T represents applying time, the applied energy E can be expressed in the following equation.

$$E=T\left(\frac{V^2}{R}\right)$$

The common drop phenomenon has a characteristic in that the value of the voltage drop is nearly proportional to the number of the simultaneously heated dots in one line of TPH 40; that is to say, the higher the number of the simultaneously heated dots, the greater the voltage drop within TPH 40. Accordingly, the energy applied to the dots of TPH 40 becomes smaller in effect, and thereby the printing density is lowered, such that printing is performed more dimly than when fewer simultaneously heated dots are present. Common drop correcting unit 50 corrects the picture quality deterioration due to the common drop, by adjusting the heating period of a strobe signal, which uses the above proportionate relationship between the common drop and the number of the simultaneously heated dots.

Meanwhile, TPH 40 performs printing by converting electrical energy into thermal energy through a resistance. Even if the same amount of electrical energy is applied, since the heat actually generated in the respective dots of TPH 40 varies with ambient temperature fluctuations and with a heat accumulation phenomenon occurring in the thermal print head, the printing density is varied. To correct the picture quality deterioration due to TPH 40 temperature changes, a thermistor is installed on the back side of the heat element substrate of TPH 40 to detect the temperature of TPH 40. The detected temperature therein is converted to digital temperature data in analog-to-digital converter 61. The compensated data corresponding to the present detected temperature of TPH 40 is stored in the temperature correcting ROM 62. Thereafter, the SMPS of power source 63 changes the voltage applied to TPH 40 according to the stored temperature data and thereby changes the applied energy of TPH 40.

In other words, the SMPS changes the voltage applied to TPH 40 according to the input temperature data. For example, the picture quality deterioration due to the temperature change is prevented by lowering the voltage if the temperature is high, or increasing the voltage if the temperature is low.

However, the temperature correcting unit 60 for correcting the TPH temperature requires a controlling circuit which can change the voltage according to the temperature data input to the SMPS of power source 63 and further requires a connector for transmitting the

temperature data.

Summary of the Invention

According to the present invention, there is provided a thermal printer wherein printing is performed by a thermal print head (TPH) after an image data gradation value is compared with a preset gradation value in line units, the thermal printer comprising:

first detecting means for detecting the number of dots which are simultaneously heated according to gradation, by receiving said image data in line units;

second detecting means for detecting the temperature of said TPH; and

correcting means for controlling said TPH to emit heat with a substantially constant energy according to gradation, by varying a heating period according to the simultaneous-heated-by-gradation dot number detected from said first detecting means and said TPH detected from said second detecting means.

According to the present invention, there is also provided a thermal printer comprising means for received an image signal, and a print control circuit for printing by a thermal print head (TPH) after the gradation values of the received image signals are compared with a preset gradation value in line units, wherein said print control circuit comprises:

a line memory in which the received image signals are stored in line units;

a TPH controlling unit for transmitting the gradation-compared image signals to said TPH as heating data after the gradation values of said image signals stored in said line memory are compared with a preset gradation value;

first correcting means for outputting a first strobe signal which controls a heating period of said TPH depending on the detected number of dots which are simultaneously heated according to gradation, by detecting the number of simultaneous heated-by-gradation dots by receiving said data in line units;

second correcting means for outputting a second strobe signal which controls a heating period of said TPH depending on the detected temperature, by detecting the temperature of said TPH;

adding means for adding said first strobe signal output from said first correcting means to said second strobe signal output from said second correcting means; and

heating time controlling means for outputting to said TPH a strobe signal whose pulse width is varied by varying the pulse width of said strobe signal depending on the sum data of said adding means.

According to the present invention, there is also provided a thermal printer comprising means for receiving an image signal, and a print control circuit for printing by a thermal print head (TPH) after the gradation values of the received image signals are compared with a preset gradation value in line units, wherein said print control circuit comprises:

a line memory in which the received image signals are stored in line units;

a TPH controlling unit for transmitting the gradation-compared image signals to said TPH as heating data after the gradation values of said image signals stored in said line memory are compared with a preset gradation value;

first detecting means for detecting the number of dots which are simultaneously heated according to gradation, by receiving said one line image data;

second detecting means for detecting the temperature of said TPH;

a common drop and temperature correcting memory in which a strobe data which controls heating time according to the data output from said first and second detecting means is stored; and

heating time controlling means for controlling heating time according to the strobe data output from said common drop and temperature correcting memory.

The image signal receiving means may comprise a processing circuit for converting the image signals input from a signal input source into red, green and blue signals, and an image display circuit for displaying the signals processed in said image signal processing circuit.

An advantage of the present invention is that it provides a printing method suitable for use with the above thermal printer.

According to the present invention, there is provided a method for printing by a thermal print head (TPH), comprising the steps of:

firstly storing image data in screen units;

secondly storing data in line units by reading the data stored in said first storing step;

firstly detecting the number of dots which are simultaneously heated according to gradation, by receiving the data stored in said second storing step, in

line units;

secondly detecting the temperature of said TPH;

generating a strobe signal for controlling said TPH to emit heat with a substantially constant energy according to gradation, by varying the pulse width of the strobe signal according to the simultaneous-heated-by-gradation dot number detected in said first detecting step and said TPH temperature detected in said second detecting step; and

controlling said TPH to print for the period of the pulse width of the strobe signal generated in said strobe signal generating step after the gradation value of one line image data is compared with a preset gradation value, in line units.

An advantage of the present invention is that it provides a thermal printer which corrects the temperature of the thermal print head, not by varying the voltage of a switching mode power supply but by adjusting the heating period of the thermal print head, as in common drop correction, and also provides a printing method thereof.

Another advantage of the present invention is that it provides a thermal printer which corrects common drop and temperature, by apportioning the heating period of the TPH to a common-drop-correction heating period and a temperature-correction heating period, and also provides a printing method thereof.

Still another advantage of the present invention is that it provides a thermal printer which corrects common drop and temperature by adjusting the heating period using a single ROM for both common drop and temperature correction, and also provides a printing method thereof.

Brief Description of the Drawings

The above objects and other advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof, by way of example only, with reference to the attached drawings in which:

FIG.1 is a block diagram of a conventional thermal printer;

FIG.2 is a schematic diagram showing a thermistor attached to the thermal print head shown in FIG.1;

FIG.3 is a block diagram of a thermal printer according to an embodiment of the present invention;

FIG.4 is a view of a strobe signal generated in the strobe signal generator shown in FIG.3;

FIG.5 is a block diagram of a thermal printer according to another embodiment of the present invention;

FIG.6 shows the common drop and temperature correcting ROM shown in FIG.5; and

FIG.7 is a view of a strobe signal generated in the strobe signal generator shown in FIG.5.

Detailed Description of the Invention

A thermal printer according to the present invention as shown in FIG.3 is constituted by a frame memory 110 for storing the input image signal in frame units, a line memory 120 for storing the output from the frame memory 110 in line units, a TPH controlling unit 130 for gradation-comparing the image data from line memory 120 with a preset gradation value, a TPH 140, and a correcting unit 150 for correcting common drop and temperature variations by apportioning to a common-drop-correction heating period and a temperature-correction heating period according to the ambient temperature and a heat accumulation phenomenon, among the TPH heating period in accordance with the number of dots which are simultaneously heated according to gradation.

In another embodiment of the present invention, as shown in FIG.5, the configuration of frame memory 210, line memory 220, TPH controlling unit 230 and TPH 240 are the same as those of the above first embodiment. Here, however, the correcting unit 250 corrects common drop and temperature by varying the heating period using a single common drop and temperature correcting ROM 255.

Now, the operation of each embodiment of the present invention will be described.

In FIG.3, since the operations of frame memory 110, line memory 120, TPH controlling unit 130 and TPH 140 are the same as those of the corresponding elements shown in FIG.1, the description thereof is omitted herein. The description of the operation of correcting unit 150 will be accomplished largely with reference to FIG.4.

Referring to FIG.3, one line of data read from frame memory 110 is transmitted to line memory 120 and at the same time to the address terminal (ADDR) of a dot number computing memory 152 through a first selection contact point al of a controlling switch 151. Here, dot number computing memory 152 is used for computing the dot number simultaneously heated according to gradation.

The addresses corresponding to the number of gradation level are designated to dot number computing memory 152. Whenever the address is designated, the data is written in the designated address by a write enable signal output from a dot number computing controller 153. Here, dot number computing controller 153 is used for controlling the computation of the dot number simultaneously heated according to gradation.

For example, assuming that the image data is composed of eight bits and one line dots thereof total 1,000, if one line of data is composed of 100 samples of gradation 1 data, 50 samples of gradation 5 data and 850 samples of gradation 235 data, then, data values of 100, 50 and 850 are stored in addresses 1, 5 and 235 of dot number computing memory 152, respectively, and the data value of 0 is stored in all the remaining addresses because there is no corresponding data therein.

In other words, dot number computing controller 153 computes how many data values among one line of data are input by the respective gradations and then computes the number of dots simultaneously heated according to gradation.

The detailed explanation thereof is as follows.

All data stored in the addresses 1 through 255 are summed and written in the address 1 of dot number computing memory 152. Thereafter, all data stored in addresses 2 through 255 are summed and written in address 2, and likewise continuing throughout each address. Then, all data stored in addresses 254 through 255 are summed and written in address 254, with the last data value remaining in the address 255 without any summation operation occurring.

In the above-described manner, the number of simultaneous heated-by-gradation dots is computed. This is due to the printing being performed by gradations. If gradation 1 is printed, the value of a gradation counter 133 becomes "1" and the data of gradations 1 and greater 25 (the data between gradation 1 and gradation 255) among one line of data are all output as "high" (signifying heat emission) in a comparator 134. If gradation 2 is printed, the value of gradation counter 133 becomes "2" and the data of gradations 2 and greater (the data between gradation 2 and gradation 255) are thermally printed. If gradation 254 is to be printed, the value of gradation counter 133 becomes "254" and the data of gradations 254 and greater (the data of gradations 254 and 255) are thermally printed. Thereafter, the data corresponding to gradation 255 is thermally printed to thereby complete the printing of one line of data.

Meanwhile, when one line image data is read from line memory 120 and printing by gradation is performed, the gradation data which is generated in gradation counter 133 as controlling switch 151 is connected to a second selection contact point bl, is input as the address signal of dot number computing memory 152, and the data stored in the address of dot number computing memory 152 by the above dot-number-computing process is read out.

Since the number of simultaneous heated-by-gradation dots is stored in dot number computing memory 152, the data corrected from a common drop correcting ROM 154 is transmitted to a strobe signal generator 158 through adder 157 by accessing the address corresponding to the simultaneous heated-by-gradation dots.

Strobe signal generator 158 transmits the varied strobe signal by varying the pulse width of the strobe signal depending on the data output from common drop correcting ROM 154 and controls the heating period of the TPH 140.

The applied energy to the TPH 140 varies depending on the pulse width of the strobe signal. For example, the longer the pulse width of the strobe signal is, the more energy is applied. Accordingly, the greater the number of the simultaneous heated-by-gradation dots, the longer the pulse width of the strobe signal becomes, thereby correcting the decline in energy due to a common drop.

The temperature correction of the TPH 140 is performed as follows. The present temperature is detected from the thermistor (not shown) installed on the back side of heat element substrate of TPH 140 and is converted into digital data in an analog-to-digital converter 155 to be sent to temperature correcting ROM 156. A temperature correcting ROM 156 converts the data appropriately so as to correct the temperature optimally according to the input temperature data.

The adder 157 transmits the result of adding the data corrected by common drop correcting ROM 154 and temperature correcting ROM 156 to strobe signal generator 158 and varies the pulse width of the strobe signal to perform the common drop and temperature correction at the same time and in accordance with the pulse width of the varied strobe signal.

The pulse width of the strobe signal is in proportion to the data value input to strobe signal generator 158. In other words, the greater the data value becomes, the longer the pulse width of the strobe signal becomes. Also, the applied energy to the TPH 140 increases in proportion to the pulse width of the strobe signal.

As shown in FIG. 4, A^1 represents the pulse width for the common drop correction in consideration of the number of the simultaneous heated-by-gradation dots when gradation 1 is printed, A^2 represents the pulse width for the common drop correction when gradation 2 is printed, and A^{255} represents the pulse width for the common drop correction when gradation 255 is printed. Also, B^1 represents the pulse width for the temperature correction when gradation 1 is printed, B^2 represents the pulse width for the temperature correction when gradation 2 is printed, and B^{255} represents the pulse width for the temperature correction when gradation 255 is printed.

Here, the pulse width, B^1 through B^{255}, for the temperature correction, may have the same pulse width of that when one line of data is printed.

The maximum and minimum values for the pulse width of the strobe signal are determined according to the system characteristics of the thermal printer. Here, it is extremely important to set the data value input to the strobe signal generators 158 so as not to deviate from the maximum and minimum values of the pulse width of the strobe signal in any sublimation-type thermal printer, because the pulse width of the strobe signal is a factor of the applied energy to TPH 140 (see above equation).

With respect to the TPH applied energy specifications established so as to obtain a system's optimal picture quality, if these specifications are exceeded or not yet reached, the optimal picture quality may not be obtained and the TPH itself may also be damaged.

In consideration of the maximum and minimum values of the pulse width of the strobe signal, the data value input to strobe signal generator 158 should be set within a predetermined range not deviating from the maximum and minimum values so as to perform an optimal common drop and temperature correction.

That is, the output value of the temperature correcting ROM 156 for a temperature correction is set so as to output the maximum value when the TPH temperature set by the system is the lower limit value, because the higher the temperature becomes, the higher the printing density becomes. Accordingly, in order to compensate the state, the higher the TPH temperature becomes, the less energy should be applied. Then, the greater the number of simultaneous heated-by-gradation dots is, the lower the voltage applied to TPH 140 via common drop correcting ROM 154, adder 157 and strobe signal generator 158 becomes. Accordingly, the printing density is reduced.

The data value regarding the temperature correction and the data value regarding the common drop correction, set as described above, should be set so that the added value of the respective maximum values thereof is at most the maximum value of the pulse width of the strobe signal set by the system. Conversely, the added value of the respective minimum values thereof is at least the minimum value of the pulse width of the strobe signal set by the system.

FIG.5 is a block diagram of the thermal printer according to another embodiment of the present invention. The description will be made mainly regarding a correcting unit 250, which is different from the corresponding portion of FIG.3. The remaining parts of FIG. 5 are substantially the same as those of FIG. 3 and, so need no further explanation.

Referring to FIG.5, the common drop correcting ROM 154 and the temperature correcting ROM 156 shown in FIG.3 are not separately provided, nor is the adder 157 adopted. However, in order to obtain the same result as that of FIG.3, only one ROM can be used by programming so that the respective common drop data and temperature correction data are added in a common drop and temperature correcting ROM 255.

In other words, as shown in FIG.6, the data having a different pulse width of the strobe signal according to the number of the simultaneous heated-by-gradation dots output from a dot number computing memory 252 and the present TPH temperature output from an analog-to-digital converter 254 is stored in the common drop and temperature 20 correcting ROM 255.

A strobe signal generator 256 generates a strobe signal having the corresponding pulse width according to the correction data output from common drop and temperature correcting ROM 255.

The pulse width of the strobe signal shown in FIG.7. Here, C^1 represents the pulse width of the correction data output from common drop and temperature correcting ROM 255 when gradation 1 is printed, C^2 represents the pulse width of the correction data output from the common drop and temperature correcting ROM 255 when gradation 2 is printed, and C^{255} represents the pulse width of the correction data output from common drop and temperature correcting ROM 255 when gradation 255 is printed.

As described above, the thermal printer and method using the same according to the present invention improves picture quality by compensating the picture quality deterioration due to the common drop and temperature characteristics of a TPH, by using varied heating periods of the TPH.

Also, the thermal printer and method using the same according to the present invention can reduce the volume of hardware, by correcting TPH temperature by adjusting the heating period of a thermal print head as in common drop correction, without using the SMPS voltage variation, because neither a control circuit for varying voltage depending on the temperature data input to the internal SMPS of a power source unit nor a connector for transmitting temperature data are required.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s).

Claims

1. A thermal printer wherein printing is performed by a thermal print head (TPH) after an image data gradation value is compared with a preset gradation value in line units, said thermal printer comprising:

   first detecting means (152, 252) for detecting the number of dots which are simultaneously heated according to gradation, by receiving said image data in line units;

   second detecting means for detecting the temperature of said TPH; and

   correcting means (150, 250) for controlling said TPH to emit heat with a substantially constant

energy according to gradation, by varying a heating period according to the simultaneous heated-by-gradation dot number detected from said first detecting means (152, 252) and the temperature of said TPH detected from said second detecting means (152, 252).

2. A thermal printer comprising means for receiving an image signal, and a print control circuit for printing by a thermal print head (TPH) after the gradation values of the received image signals are compared with a preset gradation value in line units, wherein said print control circuit comprises:

   a line memory (120) in which the received image signals are stored in line units;

   a TPH controlling unit (130) for transmitting the gradation-compared image signals to said TPH as heating data after the gradation values of said image signals stored in said line memory (120) are compared with a preset gradation value;

   first correcting means (152, 153, 154) for outputting a first strobe signal which controls a heating period of said TPH depending on the detected number of dots which are simultaneously heated according to gradation, by detecting the number of simultaneous heated-by-gradation dots by receiving said data in line units;

   second correcting means (155, 156) for outputting a second strobe signal which controls a heating period of said TPH depending on the detected temperature, by detecting the temperature of said TPH;

   adding means (157) for adding said first strobe signal output from said first correcting means (152, 153, 154) to said second strobe signal output from said second correcting means (155, 156); and

   heating time controlling means (158) for outputting to said TPH a strobe signal whose pulse width is varied by varying the pulse width of said strobe signal depending on the sum data of said adding means (157).

3. A thermal printer as claimed in Claim 2, wherein said image signal receiving means comprises a processing circuit for converting the image signals input from a signal input source into red, green and blue signals, and an image display circuit for displaying the signals processed in said image signal processing circuit.

4. A thermal printer as claimed in claim 2 or claim 3, wherein said heating time controlling means (158) generates a strobe signal whose pulse width is varied by summation of each heating pulse width depending on the number of simultaneous heated-by-gradation dots and the temperature,and then outputs the resultant signal to said TPH.

5. A thermal printer as claimed in any one of claims 2 to 4, wherein said heating pulse width of said strobe signal is set so as not to deviate from the minimum and maximum values of the pulse width of the strobe signal applied to said TPH, which are preset by the thermal printer.

6. A thermal printer as claimed in any one of claims 2 to 5, wherein said first correcting means (152, 153, 154) comprises:

   a dot number computing memory (152) in which the computed value of the number of dots which are simultaneously heated according to gradation is stored, by receiving one line of image data;

   a dot number computing controller (153) for controlling the sum data so as to be stored in the respective gradation addresses of said dot number computing memory (152), by summing the values of said one line image data and the values of all the gradations not exceeding the gradation corresponding thereto; and

   a common drop correcting ROM (154) in which the data value of a first strobe signal is stored such that the pulse width becomes longer if the number of simultaneous heated-by-gradation dots output from said dot number computing memory (152) is greater than a reference value, and becomes shorter if the number of simultaneous heated-by-gradation dots output from said dot number computing memory (152) is less than the reference value.

7. A thermal printer as claimed in any one of claims 2 to 6, wherein said second correcting means (155, 156) comprises:

   a temperature sensor installed on the back side of the heating element substrate of said TPH;

   an analog-to-digital converter (155) for converting the temperature output from said temperature sensor into a digital signal; and

   a temperature correcting ROM (156) in which the data value of a second strobe signal responsive to the present detected temperature data output from said analog-to-digital

converter (155) is stored.

8. A thermal printer comprising means for receiving an image signal, and a print control circuit for printing by a thermal print head (TPH) after the gradation values of the received image signals are compared with a preset gradation value in line units, wherein said print control circuit comprises:

a line memory (220) in which the received image signals are stored in line units;

a TPH controlling unit (230) for transmitting the gradation-compared image signals to said TPH as heating data after the gradation values of said image signals stored in said line memory (220) are compared with a preset gradation value;

first detecting means (252, 253) for detecting the number of dots which are simultaneously heated according to gradation, by receiving said one line image data;

second detecting means (254) for detecting the temperature of said TPH;

a common drop and temperature correcting memory (255) in which a strobe data which controls heating time according to the data output from said first and second detecting means is stored; and

heating time controlling means (256) for controlling heating time according to the strobe data output from said common drop and temperature correcting memory (255).

9. A thermal printer as claimed in Claim 8, wherein said image signal receiving means comprises a processing circuit for converting the image signals input from a signal input source to red, green and blue signals, an image display circuit for displaying the signals processed in said image signal processing circuit.

10. A thermal printer as claimed in claim 8 or claim 9, wherein said heating time controlling means (256) generates a strobe signal by summation of each pulse width depending on the number of the simultaneous heated-by-gradation dots and a pulse width regarding temperature, stored in said memory (255), and then outputs the resultant signal to said TPH.

11. A thermal printer as claimed in any one of claims 8 to 10, wherein said first detecting means (252, 253) comprises:

a dot number computing memory (252) in which the computed value of the number of dots which are simultaneously heated according to gradation is stored, by receiving one line image data; and

a dot number computing controller (253) for controlling the sum data so as to be stored in the respective gradation addresses of said dot number computing memory (252), by summing the values of said one line image data and the values of all the gradations not exceeding the gradation corresponding thereto.

12. A thermal printer as claimed in any one of claims 8 to 11, wherein said second detecting means (254) comprises:

a temperature sensor installed on the back side of the heating element substrate of said TPH; and

an analog-to-digital converter (254) for converting the temperature output from said temperature sensor into a digital signal.

13. A method for printing by a thermal print head (TPH), comprising the steps of:

firstly storing image data in screen units;

secondly storing data in line units by reading the data stored in said first storing step;

firstly detecting the number of dots which are simultaneously heated according to gradation, by receiving the data stored in said second storing step, in line units;

secondly detecting the temperature of said TPH;

generating a strobe signal for controlling said TPH to emit heat with a substantially constant energy according to gradation, by varying the pulse width of the strobe signal according to the simultaneous heated-by- gradation dot number detected in said first detecting step and said TPH temperature detected in said second detecting step; and

controlling said TPH to print for the period of the pulse width of the strobe signal generated in said strobe signal generating step after the gradation value of one line image data stored in said second storing step is compared with a preset gradation value, in line units.

Patentansprüche

1. Ein Wärmedrucker, worin Drucken durch einen Wärmedruckkopf ausgeführt wird, nachdem ein Bilddatengradationswert mit einem vorgesetzten Gradationswert in Zeileneinheiten verglichen wird, wobei der genannte Wärmedrucker umfaßt:

    eine erste Bestimmungseinrichtung (152, 255) zum Bestimmen der Anzahl von Punkten, die gleichzeitig gemäß der Gradation erwärmt werden, indem die genannten Bilddaten in Zeileneinheiten erhalten werden;

    eine zweite Bestimmungseinrichtung zum Bestimmen der Temperatur des genannten Wärmedruckkopfes; und

    eine Korrektureinrichtung (150, 250) zum Steuern des genannten Wärmedruckkopfes, um Wärme mit einer im wesentlichen konstanten Energie gemäß der Gradation auszusenden, indem eine Heizdauer gemäß der gleichzeitig wegen der Gradation erwärmten Punktzahl verändert wird, die von der genannten ersten Bestimmungseinrichtung (152, 252) bestimmt wird und der Temperatur des genannten Wärmedruckkopfes, die von der genannten zweiten Bestimmungseinrichtung (152, 252) bestimmt wird.

2. Ein Wärmedrucker, der eine Einrichtung zum Erhalten eines Bildsignals und eine Drucksteuerschaltung zum Drucken durch einen Wärmedruckkopf umfaßt, nachdem die Gradationswerte der empfangenen Bildsignale mit einem vorgesetzten Gradationswert in Zeileneinheiten verglichen worden sind, worin die genannte Drucksteuerschaltung umfaßt:

    einen Zeilenspeicher (120), in dem die erhaltenen Bildsignale in Zeileneinheiten gespeichert sind;

    eine Wärmedruckkopf-Steuereinheit (130) zum Übertragen der gradationsverglichenen Bildsignale zu dem genannten Wärmedruckkopf als Wärmedaten, nachdem die Gradationswerte der genannten Bildsignale, die in dem genannten Zeilenspeicher (120) gespeichert sind, mit einem vorgesetzten Gradationswert verglichen worden sind;

    eine erste Korrektureinrichtung (152, 153, 154) zum Ausgeben eines ersten Tastimpulssignals, das eine Heizdauer des genannten Wärmedruckkopfes in Abhängigkeit von der bestimmten Anzahl von Punkten steuert, die gleichzeitig gemäß der Gradation erwärmt werden, indem die Anzahl von gleichzeitig aufgrund der Gradation erwärmten Punkte durch Erhalten der genannten Daten in Zeileneinheiten bestimmt wird;

    eine zweite Korrektureinrichtung (155, 156) zum Ausgeben eines zweiten Tastimpulssignals, das eine Heizdauer des genannten Wärmedruckkopfes in Abhängigkeit von der bestimmten Temperatur steuert, indem die Temperatur des genannten Wärmedruckkopfes bestimmt wird;

    eine Addiereinrichtung (157) zum Addieren des genannten ersten Tastimpulssignals, das von der genannten ersten Korrektureinrichtung (152, 153, 154) ausgegeben wird, zu dem genannten zweiten Tastimpulssignal, das von der genannten zweiten Korrektureinrichtung (155, 156) ausgegeben wird; und

    eine Heizdauersteuereinrichtung (158), zum Ausgeben eines Tastimpulssignals an den genannten Wärmedruckkopf, dessen Impulsbreite geändert wird, indem die Impulsbreite des genannten Tastimpulssignals in Abhängigkeit von der Summendate der genannten Addiereinrichtung (157) geändert wird.

3. Ein Wärmedrucker, wie in Anspruch 2 beansprucht, worin die genannte Bildsignalempfangseinrichtung eine Verarbeitungsschaltung zum Umwandeln der Bildsignale, die von einer Signaleingangsquelle eingegeben werden, in rote, grüne und blaue Signale, und eine Bildanzeigeschaltung zum Anzeigen der Signale umfaßt, die in der genannten Bildsignalverarbeitungsschaltung verarbeitet werden.

4. Ein Wärmedrucker, wie in Anspruch 2 oder Anspruch 3 beansprucht, worin die genannte Heizzeitsteuereinrichtung (158) ein Tastimpulssignal erzeugt, dessen Impulsbreite durch Summierung von jeder Heizimpulsbreite in Abhängigkeit von der Anzahl gleichzeitig aufgrund der Gradation erwärmten Punkte und der Temperatur, geändert wird, und dann das sich ergebende Signal an den genannten Wärmedruckkopf ausgibt.

5. Ein Wärmedrucker, wie in irgendeinem der Ansprüche 2 bis 4 beansprucht, worin die genannte Heizimpulsbreite des genannten Tastimpulssignals so gesetzt wird, daß sie nicht von dem minimalen und dem maximalen Wert der Impulsbreite des an den genannten Wärmedruckkopf angelegten Tastimpulsignals abweicht, die durch den Wärmedrucker vorgesetzt sind.

6. Ein Wärmedrucker, wie in irgendeinem der Ansprüche 2 bis 5 beansprucht, worin die genannte erste Korrektureinrichtung (152, 153, 154) umfaßt:

einen Punktzahlberechnungsspeicher (152), in dem der berechnete Wert der Anzahl der Punkte, die gleichzeitig gemäß der Gradation erwärmt werden, gespeichert wird, indem eine Zeile Bilddaten erhalten wird;

eine Punktzahlberechnungssteuerung (153) zum Steuern der Summendaten, so daß sie in den entsprechenden Gadationsadressen des genannten Punktzahlberechnungsspeichers (152) gespeichert werden, indem die Werte der genannten Bilddaten einer Zeile und die Werte aller der Gradationen, die die dazu entsprechende Gradation nicht überschreiten, aufsummiert werden; und

einen den allgemeinen Abfall korrigierenden Nurlesespeicher ROM (154), in dem der Datenwert eines ersten Tastimpulssignals gespeichert wird, so daß die Impulsbreite länger wird, wenn die Anzahl der gleichzeitig aufgrund der Gradation erwärmten Punkte, die von dem genannten Punktzahlberechnungsspeicher (152) ausgegeben wird, größer als ein Bezugswert ist, und kürzer wird, wenn die Anzahl der gleichzeitig aufgrund der Gradation erwärmten Punkte, die von dem genannten Punktzahlberechnungsspeicher (152) ausgegeben wird, kleiner als der Bezugswert wird.

7. Ein Wärmedrucker, wie in irgendeinem der Ansprüche 2 bis 6 beansprucht, worin die genannte zweite Korrektureinrichtung (155, 156) umfaßt:

einen Temperaturfühler, der auf der Rückseite des Wärmeelementsubstrats des genannten Wärmedruckkopfes eingebaut ist;

ein Analog/Digitalwandler (155) zum Umwandeln der Temperatur, die von dem genannten Temperaturfühler ausgegeben wird, in ein digitales Signal; und

ein temperaturkorrigierender Nurlesespeicher ROM (156), in dem der Datenwert eines zweiten Tastimpulssignals, das auf die gegenwärtig bestimmte Temperaturdate reagiert, die von dem genannten Analog/Digitalwandler (155) ausgegeben wird, gespeichert ist.

8. Ein Wärmedrucker, der eine Einrichtung zum Erhalten eines Bildsignals und eine Drucksteuerschaltung zum Drucken durch einen Wärmedruckkopf umfaßt, nachdem die Gradationswerte der empfangenen Bildsignale mit einem vorgesetzten Gradationswert in Zeileneinheiten verglichen werden, worin die genannte Drucksteuerschaltung umfaßt:

einen Zeilenspeicher (120), in dem die erhaltenen Bildsignale in Zeileneinheiten gespeichert sind;

eine Wärmedruckkopf-Steuereinheit (230) zum Übertragen der gradationsverglichenen Bildsignale zu dem genannten Wärmedruckkopf als Wärmedaten, nachdem die Gradationswerte der genannten Bildsignale, die in dem genannten Zeilenspeicher (220) gespeichert sind, mit einem vorgesetzten Gradationswert verglichen worden sind;

eine erste Bestimmungseinrichtung (252, 255) zum Bestimmen der Anzahl von Punkten, die gleichzeitig gemäß der Gradation erwärmt werden, indem die genannten Bilddaten in Zeileneinheiten erhalten werden;

eine zweite Bestimmungseinrichtung (254) zum Bestimmen der Temperatur des genannten Wärmedruckkopfes; und

einen Korrekturspeicher (255) für den allgemeinen Abfall und die Temperatur, in dem eine Tastimpulsdate gespeichert ist, die die Heizzeit gemäß der Date steuert, die von der genannten ersten und zweiten Bestimmungseinrichtung ausgegeben wird; und

eine Heizzeitsteuereinrichtung (256) zum Steuern der Heizzeit gemäß der Tastimpulsdate, die von dem genannten Korrekturspeicher (255) für den allgemeinen Abfall und die Temperatur ausgegeben wird.

9. Ein Wärmedrucker, wie in Anspruch 8 beansprucht, worin die genannte Bildsignalempfangseinrichtung eine Verarbeitungsschaltung zum Umwandeln der Bildsignale, die von einer Signaleingangsquelle eingegeben werden, in rote, grüne und blaue Signale und eine Bildanzeigeschaltung zum Anzeigen der Signale umfaßt, die in der genannten Bildsignalverarbeitungsschaltung verarbeitet werden.

10. Ein Wärmedrucker, wie in Anspruch 8 oder Anspruch 9 beansprucht, worin die genannte Heizzeitsteuereinrichtung (256) ein Tastimpulssignal durch Summierung von jeder Impulsbreite erzeugt, die von der Anzahl der gleichzeitig aufgrund der Gradation erwärmten Punkte und einer Impulsbreite bezüglich der Temperatur abhängt, die in dem genannten Speicher (255) gespeichert sind, und dann das sich ergebende Signal an den genannten Wärmedruckkopf ausgibt.

11. Ein Wärmedrucker, wie in irgendeinem der Ansprüche 8 bis 10 beansprucht, worin die genannte erste Bestimmungseinrichtung (252, 253) umfaßt:

einen Punktzahlberechnungsspeicher (252), in dem der berechnete Wert der Anzahl der Punkte, die gleichzeitig gemäß der Gradation erwärmt werden, gespeichert wird, indem eine Zeile Bilddaten erhalten wird;

eine Punktzahlberechnungssteuerung (253) zum Steuern der Summendaten, damit sie in den entsprechenden Gadationsadressen des genannten Punktzahlberechnungsspeichers (252) gespeichert werden, indem die Werte der genannten Bilddaten einer Zeile und die Werte aller der Gradationen, die die dazu entsprechende Gradation nicht überschreiten, aufsummiert werden.

12. Ein Wärmedrucker, wie in irgendeinem der Ansprüche 8 bis 11 beansprucht, worin die genannte zweite Bestimmungseinrichtung (254) umfaßt:

einen Temperaturfühler, der auf der Rückseite des Wärmeelementsubstrats des genannten Wärmedruckkopfes eingebaut ist;

ein Analog/Digitalwandler (254) zum Umwandeln der Temperatur, die von dem genannten Temperaturfühler ausgegeben wird, in ein digitales Signal.

13. Ein Verfahren zum Drucken durch einen Wärmedruckkopf, das die Schritte umfaßt:

erstens, Speichern von Bilddaten in Schirmeinheiten;

zweitens Speichern von Daten in Zeileneinheiten, indem die bei dem genannten ersten Schritt gespeicherten Daten gelesen werden;

erstes Bestimmen der Anzahl von Punkten, die gleichzeitig gemäß der Gradation erwärmt werden, indem die Daten in Zeileneinheiten erhalten werden, die in dem genannten zweiten Speicherschritt gespeichert worden sind;

zweites Bestimmen der Temperatur des genannten Wärmedruckkopfes;

Erzeugen eines Tastimpulssignals zum Steuern des genannten Wärmedruckkopfes, um Wärme mit einer im wesentlichen konstanten Energie gemäß der Gradation auszusenden, indem die Impulsbreite des Tastimpulssignals gemäß der gleichzeitig aufgrund der Gradation erwärmten Punktanzahl verändert wird, die bei dem genannten ersten Bestimmungsschritt bestimmt worden ist, und der genannten Temperatur des Wärmedruckkopfes, die bei dem genannten zweiten Bestimmungsschritt bestimmt worden ist; und

Steuern des genannten Wärmedruckkopfes, um während der Dauer der Impulsbreite des Tastimpulssignals zu drucken, das bei dem genannten Tastimpulssignalerzeugungsschritt erzeugt worden ist, nachdem der Gradationswert von Bilddaten einer Zeile, die bei dem genannten zweiten Speicherschritt gespeichert worden sind, mit einem vorgesetzten Gradationswert in Zeileneinheiten verglichen werden.

Revendications

1. Imprimante thermique dans laquelle l'impression est exécutée par une tête d'impression thermique (TPH) après qu'une valeur de gradation de données d'image a été comparée à une valeur de gradation préréglée dans des unités de ligne, ladite imprimante thermique comprenant :

des premiers moyens de détection (152, 252) pour détecter le nombre de points qui sont simultanément chauffés selon la gradation, en recevant lesdites données d'image dans des unités de ligne ;
des seconds moyens de détection pour détecter la température de ladite TPH ; et
des moyens de correction (150, 250) pour commander ladite TPH pour émettre de la chaleur avec une énergie sensiblement constante selon la gradation, en modifiant une période de chauffage selon le nombre de points simultanément chauffés par gradation détecté depuis lesdits premiers moyens de détection (152, 252) et la température de ladite TPH détectée depuis lesdits seconds moyens de détection (152, 252).

2. Imprimante thermique comprenant des moyens pour recevoir un signal d'image, et un circuit de commande d'impression pour une impression par une tête d'impression thermique (TPH) après que les valeurs de gradation des signaux d'image reçus ont été comparées à une valeur de gradation préréglée dans des unités de ligne, dans laquelle ledit circuit de commande d'impression comprend :

une mémoire de ligne (120) dans laquelle les signaux d'image reçus sont mémorisés dans des unités de ligne ;
une unité de commande de TPH (130) pour émettre les signaux d'image à gradation comparée vers ladite TPH sous la forme de données de chauffage après que les valeurs de gradation desdits signaux d'image mémorisés dans ladite mémoire de ligne (120) ont été comparées à une valeur de gradation préréglée ;

des premiers moyens de correction (152, 153, 154) pour sortir un premier signal de transfert qui commande une période de chauffage de ladite TPH selon le nombre de points détectés qui sont simultanément chauffés selon la gradation, en détectant le nombre de points simultanément chauffés par gradation en recevant lesdites données dans des unités de ligne ;

des seconds moyens de correction (155, 156) pour sortir un second signal de transfert qui commande une période de chauffage de ladite TPH selon la température détectée, en détectant la température de ladite TPH ;

des moyens d'addition (157) pour additionner ledit premier signal de transfert sorti depuis lesdits premiers moyens de correction (152, 153, 154) audit second signal de transfert sorti depuis lesdits seconds moyens de correction (155, 156) ; et

des moyens de commande de temps de chauffage (158) pour sortir vers ladite TPH un signal de transfert dont la largeur d'impulsion est modifiée en modifiant la largeur d'impulsion dudit signal de transfert selon les données d'addition desdits moyens d'addition (157).

3. Imprimante thermique selon la revendication 2, dans laquelle lesdits moyens de réception de signal d'image comprennent un circuit de traitement pour convertir les signaux d'image entrés depuis une source d'entrée de signaux en signaux rouges, verts et bleus et un circuit d'affichage d'image pour afficher les signaux traités dans ledit circuit de traitement de signal d'image.

4. Imprimante thermique selon la revendication 2 ou 3, dans laquelle lesdits moyens de commande de temps de chauffage (158) produisent un signal de transfert dont la largeur d'impulsion est modifiée par l'addition de chaque largeur d'impulsion de chauffage selon le nombre de points simultanément chauffés par gradation et la température, puis sortent le signal qui en résulte vers ladite TPH.

5. Imprimante thermique selon l'une quelconque des revendications 2 à 4, dans laquelle ladite largeur d'impulsion de chauffage dudit signal de transfert est fixée de manière à ne pas dévier des valeurs minimales et maximales de la largeur d'impulsion du signal de transfert appliqué à ladite TPH, qui sont préréglées par l'imprimante thermique.

6. Imprimante thermique selon l'une quelconque des revendications 2 à 5, dans laquelle lesdits premiers moyens de correction (152, 153, 154) comprennent :

une mémoire de calcul de nombre de points (152) dans laquelle la valeur calculée du nombre de points qui sont simultanément chauffés selon la gradation est mémorisée, en recevant une ligne de données d'image ;

un circuit de commande de calcul de nombre de points (153) pour commander les données d'addition de sorte que celles-ci sont mémorisées dans les adresses de gradation respectives de ladite mémoire de calcul de nombre de points (152), en additionnant les valeurs desdites données d'image d'une ligne et les valeurs de toutes les gradations ne dépassant pas la gradation correspondante ; et

une ROM commune de correction de chute (154) dans laquelle la valeur de données d'un premier signal de transfert est mémorisée de sorte que la largeur d'impulsion devient plus longue si le nombre de points simultanément chauffés par gradation sortis depuis ladite mémoire de calcul de nombre de points (152) est supérieur à une valeur de référence, et devient plus courte si le nombre de points simultanément chauffés par gradation sortis depuis ladite mémoire de calcul de nombre de points (152) est inférieur à la valeur de référence.

7. Imprimante thermique selon l'une quelconque des revendications 2 à 6, dans laquelle lesdits seconds moyens de correction (155, 156) comprennent :

un capteur de température installé à l'arrière du substrat d'élément de chauffage de ladite TPH ;

un convertisseur analogique-numérique (155) pour convertir la température sortie depuis ledit capteur de température en un signal numérique ; et

une ROM de correction de température (156) dans laquelle la valeur de données d'un second signal de transfert sensible aux données de température présente détectée sorties depuis ledit convertisseur analogique-numérique (155) est mémorisée.

8. Imprimante thermique comprenant des moyens pour recevoir un signal d'image, et un circuit de commande d'impression pour une impression par une tête d'impression thermique (TPH) après que les valeurs de gradation des signaux d'image reçus ont été comparées à une valeur de gradation préréglée dans des unités de ligne, dans laquelle ledit circuit de commande d'impression comprend :

une mémoire de ligne (220) dans laquelle les signaux d'image reçus sont mémorisés dans des unités de ligne ;

une unité de commande de TPH (230) pour émettre les signaux d'image à gradation comparée vers ladite TPH sous la forme de don-

nées de chauffage après que les valeurs de gradation desdits signaux d'image mémorisés dans ladite mémoire de ligne (220) ont été comparées à une valeur de gradation préréglée ;
des premiers moyens de détection (252, 253) pour détecter le nombre de points qui sont simultanément chauffés selon la gradation, en recevant lesdites données d'image d'une ligne ;
des seconds moyens de détection (254) pour détecter la température de ladite TPH ;
une mémoire commune de correction de chute et de température (255) dans laquelle des données de transfert qui commandent le temps de chauffage selon les données sorties depuis lesdits premiers et seconds moyens de détection sont mémorisées ; et
des moyens de commande de temps de chauffage (256) pour commander le temps de chauffage selon les données de transfert sorties depuis ladite mémoire commune de correction de chute et de température (255).

9. Imprimante thermique selon la revendication 8, dans laquelle lesdits moyens de réception de signal d'image comprennent un circuit de traitement pour convertir les signaux d'image entrés depuis une source d'entrée de signaux en signaux rouges, verts et bleus, un circuit d'affichage d'image pour afficher les signaux traités dans ledit circuit de traitement de signal d'image.

10. Imprimante thermique selon la revendication 8 ou 9, dans laquelle lesdits moyens de commande de temps de chauffage (256) produisent un signal de transfert en additionnant chaque largeur d'impulsion selon le nombre des points simultanément chauffés par gradation et une largeur d'impulsion concernant la température, mémorisée dans ladite mémoire (255), puis sortent le signal qui en résulte vers ladite TPH.

11. Imprimante thermique selon l'une quelconque des revendications 8 à 10, dans laquelle lesdits premiers moyens de détection (252, 253) comprennent :

une mémoire de calcul de nombre de points (252) dans laquelle la valeur calculée du nombre de points qui sont simultanément chauffés selon la gradation est mémorisée, en recevant des données d'image d'une ligne ; et
un circuit de commande de calcul de nombre de points (253) pour commander les données d'addition de sorte que celles-ci sont mémorisées dans les adresses de gradation respectives de ladite mémoire de calcul de nombre de points (252), en additionnant les valeurs desdites données d'image d'une ligne et les valeurs de toutes les gradations ne dépassant pas la gradation correspondante.

12. Imprimante thermique selon l'une quelconque des revendications 8 à 11, dans laquelle lesdits seconds moyens de détection (254) comprennent :

un capteur de température installé à l'arrière du substrat d'élément de chauffage de ladite TPH ; et
un convertisseur analogique-numérique (254) pour convertir la température sortie depuis ledit capteur de température en un signal numérique.

13. Procédé pour une impression par une tête d'impression thermique (TPH), comprenant les étapes consistant à :

mémoriser tout d'abord des données d'image dans des unités d'écran ;
mémoriser ensuite des données dans des unités de ligne en lisant les données mémorisées dans ladite première étape de mémorisation ;
détecter tout d'abord le nombre de points qui sont simultanément chauffés selon la gradation, en recevant les données mémorisées dans ladite seconde étape de mémorisation, dans des unités de ligne ;
détecter ensuite la température de ladite TPH ;
produire un signal de transfert pour commander ladite TPH pour émettre de la chaleur avec une énergie sensiblement constante selon la gradation, en modifiant la largeur d'impulsion du signal de transfert selon le nombre de points simultanément chauffés par gradation détecté dans ladite première étape de détection et ladite température de TPH détectée dans ladite seconde étape de détection ; et
commander ladite TPH pour une impression durant la période de la largeur d'impulsion du signal de transfert produit dans ladite étape de génération de signal de transfert après que la valeur de gradation de données d'image d'une ligne mémorisées dans ladite seconde étape de mémorisation a été comparée à une valeur de gradation préfixée, dans des unités de ligne.

FIG. 1 (PRIOR ART)

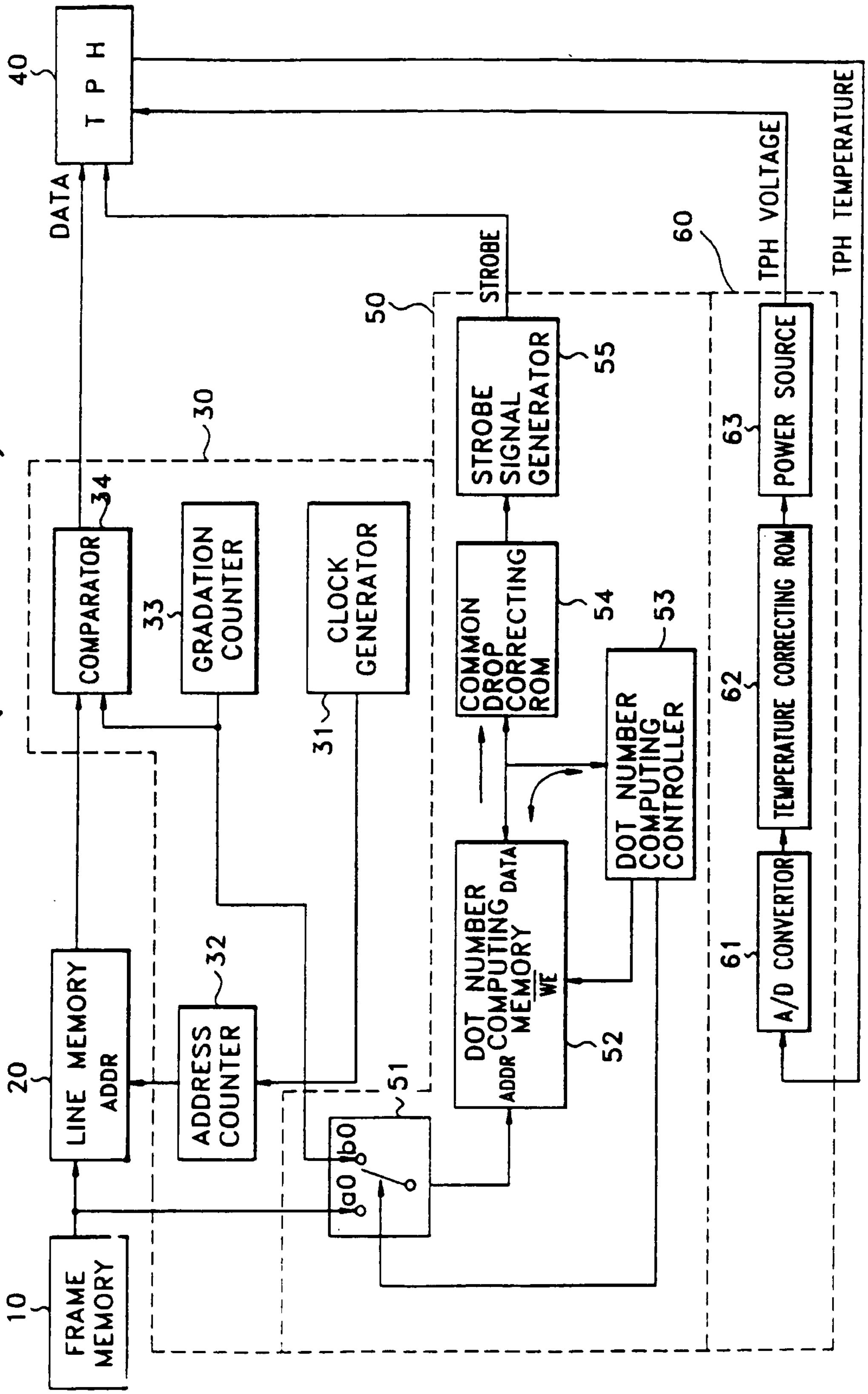


FIG. 2 (PRIOR ART)

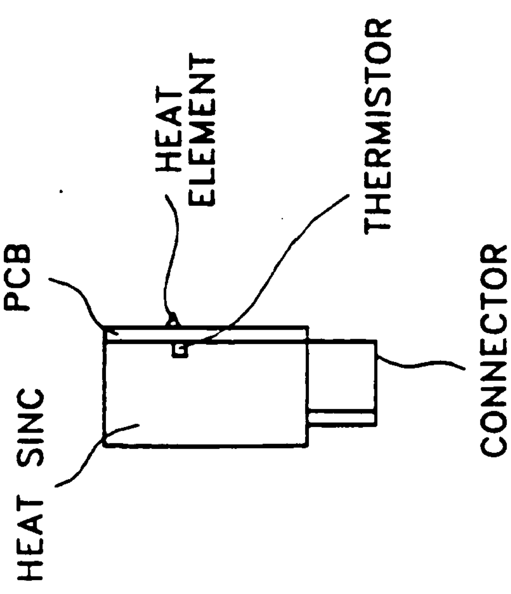


FIG. 6

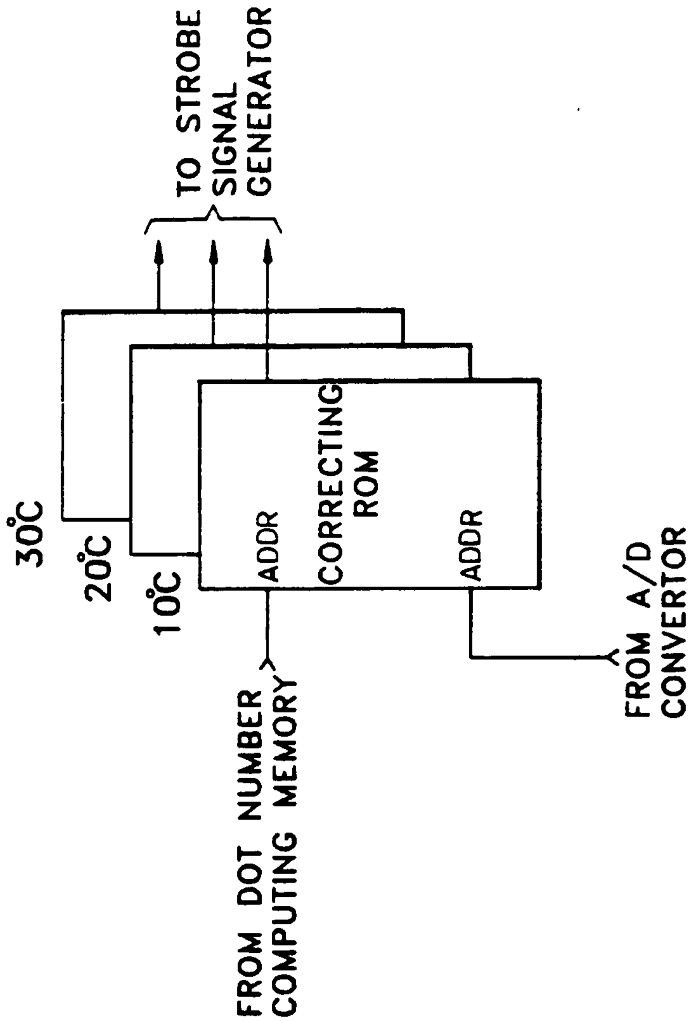


FIG. 3

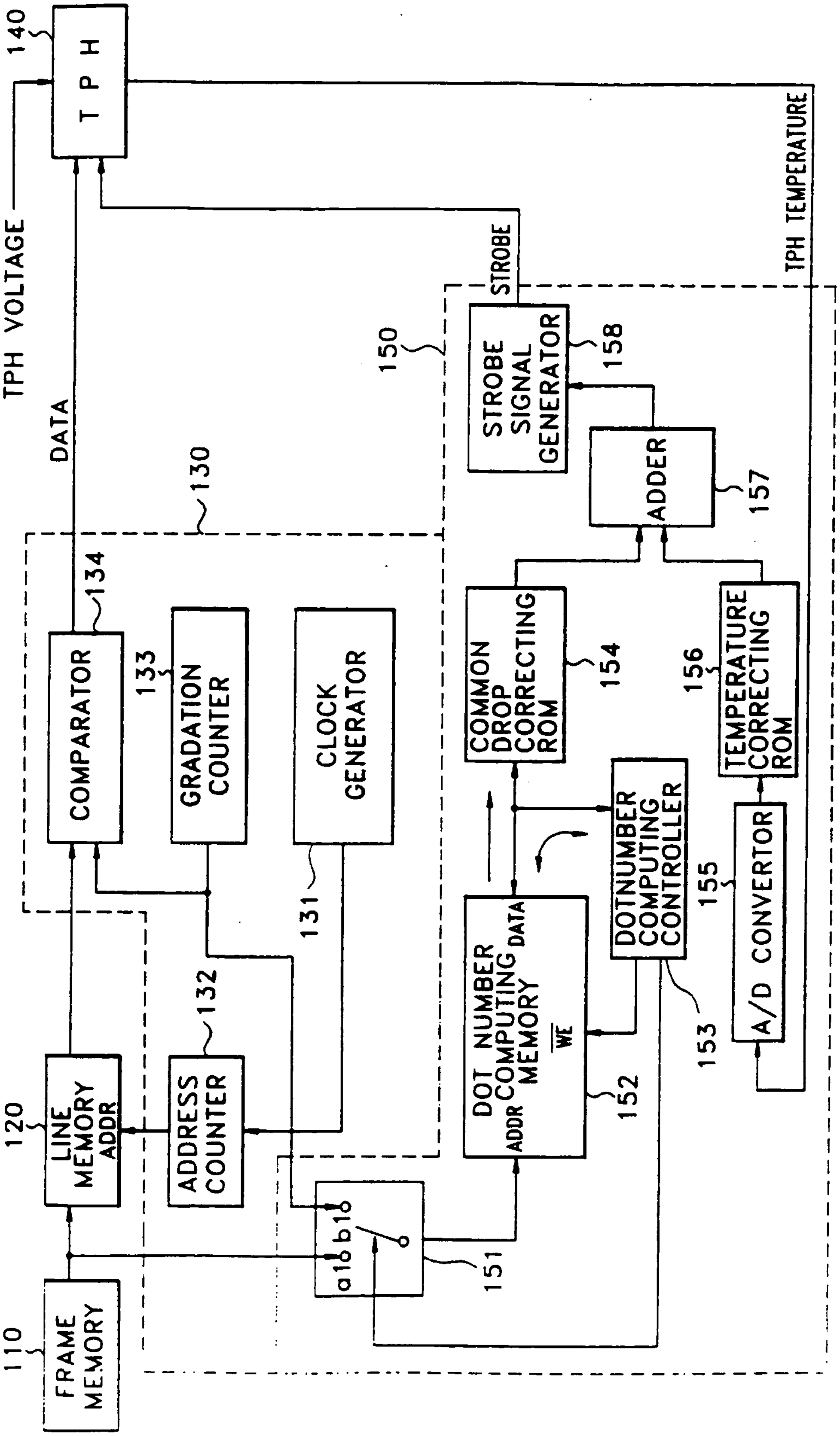

140
T P H
TPH VOLTAGE
DATA
STROBE
TPH TEMPERATURE
130
134
COMPARATOR
133
GRADATION COUNTER
CLOCK GENERATOR
131
150
STROBE SIGNAL GENERATOR
158
ADDER
157
COMMON DROP CORRECTING ROM
154
TEMPERATURE CORRECTING ROM
156
DOTNUMBER COMPUTING CONTROLLER
155
A/D CONVERTOR
153
DOT NUMBER COMPUTING MEMORY
DATA
ADDR
WE
152
120
LINE MEMORY
ADDR
ADDRESS COUNTER
132
a
b
151
110
FRAME MEMORY

FIG. 4

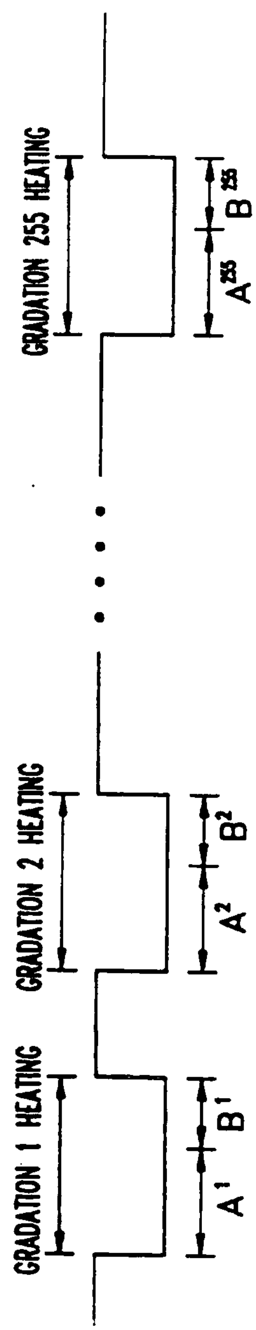

GRADATION 1 HEATING
GRADATION 2 HEATING
GRADATION 255 HEATING
A1
B1
A2
B2
A255
B255

FIG. 7

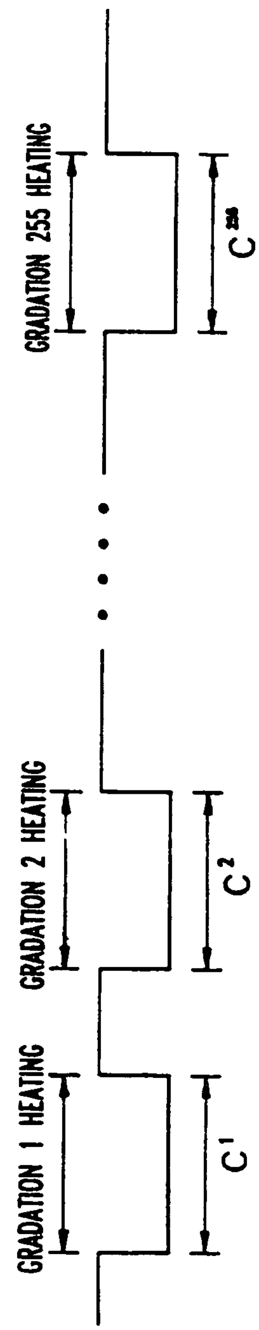
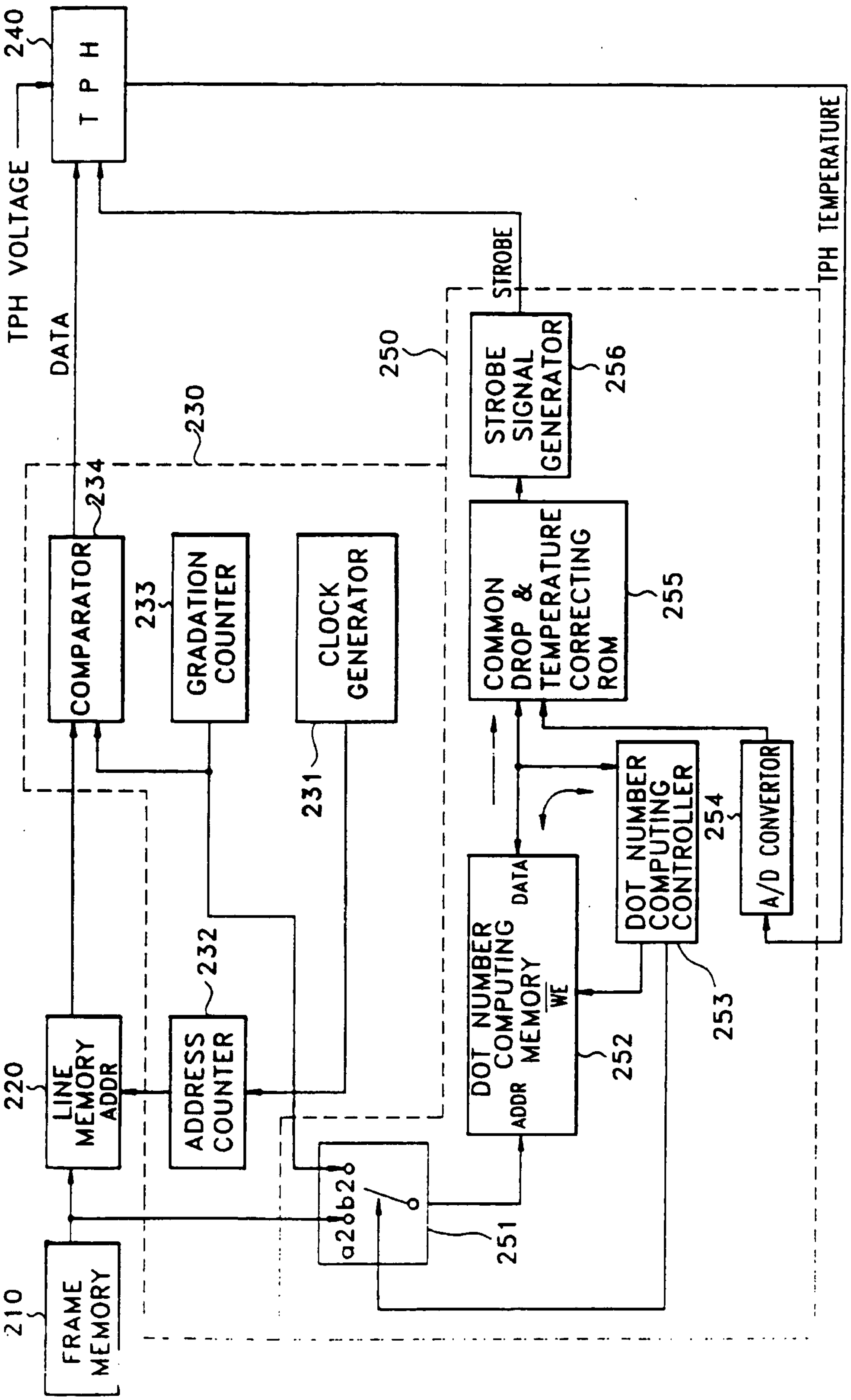

GRADATION 1 HEATING
GRADATION 2 HEATING
GRADATION 255 HEATING
C1
C2
C

FIG. 5


240
T P H
TPH VOLTAGE
DATA
TPH TEMPERATURE
STROBE
230
250
234
COMPARATOR
233
GRADATION COUNTER
CLOCK GENERATOR
231
STROBE SIGNAL GENERATOR
256
COMMON DROP & TEMPERATURE CORRECTING ROM
255
DOT NUMBER COMPUTING CONTROLLER
254
A/D CONVERTOR
253
DOT NUMBER COMPUTING MEMORY
DATA
ADDR
WE
252
220
LINE MEMORY
ADDR
ADDRESS COUNTER
232
210
FRAME MEMORY
a2
b2
251